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ORIGINAL RESEARCH

EXERCISE INTERVENTION FOR INDIVIDUALS WITH DYSFUNCTIONAL BREATHING: A MATCHED CONTROLLED TRIAL

Kyle Kiesel, PT, PhD[1]
Madison Burklow, DPT[2]
Mary Beth Garner, DPT[3]
Josh Hayden, DPT[4]
AJ Hermann, DPT[5]
Elizabeth Kingshott, DPT[7]
Greg McCullough, DPT[8]
Risa Ricard, DPT[5]
Gabby Stubblefield, SPT[1]
Jessika Volz[6]
Daniel Waskiewicz, SPT[1]
Alyssa Englert, DPT[5]

ABSTRACT

Introduction: Dysfunctional breathing (DB) is common (60-80%) in adults. Individuals with DB may have decreased pain thresholds, impaired motor control and balance, and movement dysfunction. These impairments likely adversely affect performance. Research has demonstrated that DB is multi-dimensional and includes biochemical, biomechanical, and psychophysiological categories.

Purpose: The purpose of this study was to test the impact of breathing exercises in an otherwise healthy population of individuals diagnosed with at least one category of DB. It was hypothesized that the exercise program would normalize at least one category of DB.

Methods: An experimental group with DB was recruited, then the control group was matched for gender, age, BMI and activity. Baseline breathing metrics were obtained for each category of breathing dysfunction: capnography for biochemical (ETCO2 of < 35mmHg at rest = DB), HI-LO for biomechanical (upper chest or paradoxical patterns = DB), and Self-Evaluation of Breathing Questionnaire (SEBQ ≥ 25 = DB) and Nijmegen Questionnaire (≥ 22 = DB) for psychophysiological. The experimental group performed a four-week progression of home breathing exercises, once daily and the control group continued normal activities (no interventions). Re-testing of all outcome measures was performed after four weeks.

Results: Thirty-five individuals comprised the participant sample (16 experimental, 19 control, mean age 26.0 years, mean BMI of 24.3). There were no statistically significant differences between groups at baseline. Eighty-one percent of subjects in the experimental group improved in at least one category compared to 21% of subjects in the control group. Seventy-eight percent of subjects with biomechanical category of DB in the experimental group normalized this dysfunction, while none normalized in the control group, which was statistically significantly different. Twenty-seven percent of subjects with biochemical DB in the experimental group normalized, while only 25% in the control group which was not statistically different. There were only two subjects in each group with the psychophysiological category, therefore no analysis was performed.

Conclusion: Home exercises were effective in reversing the biomechanical category of DB in 78% of young, otherwise healthy adults versus no exercise. However, the exercises did not affect the biochemical category of DB. Performing a set of home exercises may be an effective option for fitness and rehabilitation providers to suggest for clients to normalize biomechanical breathing dysfunction.

Level of Evidence: 2b

Key Words: Apical breathing, disordered breathing, hypocapnia, Movement System

[1] University of Evansville, Evansville, IN, USA
[2] Encompass Health in Evansville, Evansville, IN, USA
[3] Gibson General Hospital, Star One Rehab, Fort Branch, IN, USA
[4] Orthopedic and Sports Physical Therapy, Richmond, KY, USA
[5] ProRehab PC, Evansville, IN, USA
[6] OhioHealth, Mansfield, OH, USA
[7] Skyline Medical Center, Nashville, TN, USA
[8] ProRehab PC, Louisville, KY, USA

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CORRESPONDING AUTHOR
Kyle Kiesel, PT, PhD
University of Evansville
Stone Family Center for Health Sciences,
Room 3015
Evansville, IN
812-488-2646
E-mail: kk70@evansville.edu

INTRODUCTION

Dysfunctional breathing (DB) is an overarching term used to describe a detrimental adaptation in breathing that has not been otherwise medically diagnosed.[1] DB is common in adults with the prevalence reported between 60-80%.[2,3] Individuals with DB have decreased pain thresholds, impaired motor control and balance,[4] and movement dysfunction,[5] all of which may adversely affect an individual's success in fitness activities as well as with rehabilitation programs.

Breathing involves coordinated activity of the diaphragm and pelvic floor with eccentric control of the many muscles that are associated with the thorax and abdominal wall.[6] The diaphragm also plays a crucial role related to spinal stability during movement, [7] resulting in an intimate connection between breathing, spinal stability and movement. When DB is present, this may relate to core dysfunction,[8,9] muscle imbalance,[10,11] and dysfunction in fundamental movements.[3,4,12,13] Motor control deficits of fundamental movement patterns can be considered risk factors for musculoskeletal injury, and when multiple risk factors are present, fitness and athletic performance declines have been reported.[14–17] Additionally, normal breathing is essential to maximize movement performance, especially for complex athletic tasks including throwing, jumping, hitting and other athletic movements.[12] Because of the detrimental effects that DB can have on various aspects of physical performance, implementation of a screening and intervention program designed to identify and correct DB may be a helpful addition for professionals in the fitness and rehabilitation settings.

Recently, researchers have proposed the idea that within the umbrella term of "dysfunctional breathing", perhaps different subtypes or different categories of DB exist. These different categories of DB have been described as including the biomechanical, biochemical, and psychophysiological categorys.[18] Tools are available to assess and test for each of these different categories of DB individually, and a screen for DB has also been proposed[3] to identify individuals who likely have some category of DB and therefore would benefit from additional breathing assessments or tests.

THE THREE3 CATEGORIES OF DYSFUNCTIONAL BREATHING

Biomechanical

The biomechanical category of DB refers to individuals who are demonstrate an abnormal mechanical breathing pattern. A subject demonstrating a biomechanical breathing pattern disorder would be lacking what is considered a normal diaphragmatic breathing pattern while at rest. A clinical measure to determine presence of DB in the biomechanical category is the Hi-Lo Breathing Assessment.[19] The most common disordered breathing pattern at rest is described as upper chest breathing or apical breathing.[20] In this pattern, upper chest expansion is dominant during the inspiratory phase of breathing. Another example of biomechanical breathing dysfunction has been described as a paradoxical pattern where the lower abdomen is drawn in, rather than moving outward, during the inspiratory phase.[13]

Biochemical

The biochemical category consists of individuals who exhibit reduced levels of CO_2 in the blood, otherwise known as being in a state of hypocapnia. Capnography has been identified as a reliable clinical measure of respiratory function, measuring the end tidal CO_2 ($ETCO_2$) which is the partial pressure of CO_2 exhaled by an individual.[21,22] Hypocapnia is said to be present if the $ETCO_2$ volume is $\leq$ 35 mmHg, and $ETCO_2$ has demonstrated good concurrent validity when compared to direct blood measures.[23]

Psychophysiological

The psychophysiological category is the least commonly described or identified category of DB. This category captures individuals who may have no issues with breathing during normal daily activities but can have abnormal or dysfunctional breathing under particular situations that are commonly stress-related. For these individuals, routine clinical testing for DB may return normal results, thus, self-reported questionnaires are utilized to capture this category of DB; the Nijmegen Questionnaire[24,25] and the Self Evaluation of Breathing Symptoms Questionnaire (SEBQ) are the most common.[18]

Few studies are available that have tested various interventions to reverse DB. Most studies have used the Nijmegen questionnaire as the primary outcome measure when breathing interventions have been tested. As a better understanding of the different categories of DB and definitive diagnostics for each category have emerged, more intervention studies can be conducted to determine the best manner to treat individuals with DB in order to address the different categories of DB. The purpose of this study was to test the impact of breathing exercises in an otherwise healthy population of individuals diagnosed with at least one category of DB. It was hypothesized that those who participate in the exercise program will normalize at least one category of DB. The secondary aim was to determine if the standardized breathing exercises had an effect on movement patterns as measured by the Functional Movement Screen™ (FMS™).

METHODS

Subjects ages 18-45 who were free of known respiratory disease and had no current musculoskeletal pain complaints were recruited by fliers and word of mouth. Those who were positive on a breathing screen were invited to enroll. The breathing screen,[3] includes a breath hold time measure and a four-question general survey (Table 1). Any individual below the 25 second breath hold time threshold or scoring a ≥ 2 on the survey is considered to be positive on the breathing screen and likely have some type of dysfunctional breathing. Sample size determination for the primary outcome was calculated based on the estimate that 50% of the intervention group would improve at least one category compared to 10% in the control group. Utilizing an alpha level of .05 and 80% power to detect a type II error, a sample of 19 per group was calculated.

Institutional review board approval was obtained from the University of Evansville where the study was conducted in a clinical lab setting. At baseline, gold standard breathing metrics were obtained for each of the three categories. This included capnography for the biochemical category, ($ETCO_2$ of < 35mmHg at rest was considered DB) the HI-LO test for the biomechanical category (upper chest or paradoxical patterns was considered DB), and the SEBQ (≥ 25 = DB) and Nijmegen Questionnaire (≥ 22 = DB) for breathing symptoms related to the psychophysiological category. The experimental group was recruited first, then the control group was recruited and matched for gender, age, BMI and activity level.

The experimental group performed a four-week progression of home exercises designed to improve breathing metrics while the control group was told to continue normal activities (had no intervention). Re-testing of breathing metrics for each category was performed four weeks after baseline for both groups.

Breathing Measures

Biomechanical Category

In order to determine if a subject had a biomechanical breathing problem, the Hi-Lo Breathing Assessment[19] was utilized. The Hi-Lo is a manual assessment to determine if a subject is in a normal diaphragmatic breathing pattern or if they are in an abnormal pattern. It was performed in the sitting position with the tester standing or kneeling

Table 1. *Screen for dysfunctional breathing.*

Breathing is considered dysfunctional if breath hold time is < 25 seconds, or if any one of the following questions is scored as 2 or 3, the screen is considered positive (+) for the presence of dysfunctional breathing:
0) never/not true at all; (1) occasionally/a bit true; (2) frequently-mostly true; and, (3) very frequently/very true
Do you feel tense?
Do you feel a cold sensation in your hands or feet?
Do you notice yourself yawning?
Do you notice breathing through your mouth at night?

at the front and slightly to the side of the subject. The tester placed one hand on the subject's sternum and one hand on the upper abdomen to determine whether thoracic or abdominal motion was dominant during breathing. Assessment for paradoxical breathing was also performed by determining if the abdomen moves in a direction opposite to the thorax during breathing; this is evident during inhalation if the abdomen moves toward the spine, and during exhalation if the abdomen moves in an outward direction. The scoring process was as follows: Is the upper chest dominant? If yes scores as dysfunctional and stop, if no continue. Is the pattern paradoxal? If yes score as dysfunctional and stop, if no continue. Is diaphragm dominant? (greater volume and diaphragmatic movement is first), if yes score as functional, if no score as dysfunctional. The Hi-Lo test reliability has been reported by others as acceptable (moderate agreement)[13] and the researchers in this study achieved 88% agreement with a Kappa = .75 on 43 subjects.[3]

Biochemical Category

In order to determine if a subject had a biochemical breathing problem, capnography was utilized as the reference measure. Capnography is a measurement taken via nasal cannula to determine ETCO2. The average resting value over a three minute data collection period was utilized to obtain the measure, and the standard value of < 35 mmHg was utilized as the cut-off for dysfunction.[21-24] The capnography unit (DRE Echo C02 Avante Health Solutions, USA) was calibrated according to the manufacturer recommended procedure prior to each data collection session. Respiration rate in breaths per minute was calculated from the capnography data.

Psychophysiological Category

In order to address the psychophysiological category, two separate breathing questionnaires were administered. The Nijmegen Questionnaire is a 16-item questionnaire originally developed in the 1980's to identify patients who have breathing dysfunction that is related to common diseases. A cut score of ≥ 22 on the Nijmegen was utilized to define DB.[19,26] The Self-Evaluation of Breathing Questionnaire (SEBQ), Version 3,[27,28] is a questionnaire that includes 25 questions to determine self-perception of breathing dysfunction. Test-retest reliability has been shown to be high, and a cut score of ≥ 25 on the SEBQ was utilized to operationally define DB for this study. The SEBQ is a new tool, and there is no established cut-score confirmed in the literature to define those with this category of breathing dysfunction. Expert opinion suggests a score of 25 as an appropriate cut-score and this was the score utilized in the study that created the screen for DB.[3]

A secondary aim of this study was to determine if the exercise program, designed to improve breathing metrics, had an effect on movement. Therefore, FMS™ scores were obtained at baseline and at post testing and analyzed for within group and between group change. The FMS™ consists of seven different fundamental movement patterns and is scored on a four-point ordinal scale. The reliability of the FMS™ is well established.[29-31] Standardized testing instructions were utilized, and the two testers were trained in the FMS™ testing protocol in their didactic program.

EXERCISE INTERVENTION

Instruction on how to perform each exercise was provided by a student researcher who was trained by the primary researcher. The first set of exercises was performed for the first two weeks, then subjects met with the student researcher again to learn the progression of exercises for the second two weeks. The exercises emphasized the use of nasal inhalation and slow and full exhalation through the lips. A postural progression based on a neurodevelopmental approach was utilized with the earliest exercises (first two weeks) performed in the sidelying and hooklying postures, with progression to quadruped, half-kneeling and lastly standing (weeks 3-4). Appendix 1 provides the details of each exercise used in this study.

STATISTICAL METHODS

To determine if there were baseline differences between the control and treatment groups, T-tests were conducted on the continuous variables and the Chi-square test performed on categorical variables with the $p < 0.05$ considered significant for each. Frequency counts of subjects who demonstrated a change in at least one category of DB from pre to post testing were obtained for each group. Chi-square testing and the number needed to treat (NNT) statistic with the 95% CI were performed. Further investigation into which categories of DB changed were also calculated. Within group pre to posttest composite scores, treated as a continuous variable, on the FMS™ composite scores were analyzed for change using the paired t-test. The independent t-test was utilized to assess for between group change. Additionally, to determine if there were any changes on the FMS™ from a Pass/Fail perspective (fail defined as presence of any score of 1 or 0), the Chi-square test was performed.

RESULTS

Of the 35 total subjects analyzed, there were significantly more females 29, compared to six males ($p < .05$). There were no differences of age, male 22.2 (1.4), female 20.7(1.8) years, BMI, male 24.5 (4.4), female 23.0 (2.5), or activity level, (male 5.1(1.9), female 4.7 (1.5) between sexes. There were no significant at baseline between the control vs. experimental group (Table 2). There were initially 25 subjects enrolled into the intervention group. Of those, five were not diagnosed with DB in any category and were excluded from participation in the study. An additional four subjects did not return for the post testing and were dropped from final analysis. There were 26 initially enrolled in the control group; six did not present with any DB and were therefore excluded, and one was ill and did not return for post testing and was therefore dropped from final analysis. Ultimately, 16 subjects were analyzed in the experimental group and 19 in the control group (see Figure). There were no baseline characteristic differences between groups (Table 2). In the experimental group, 81% of subjects improved by at least one breathing category compared to 21% of controls ($p < .001$, NNT = 2 [2-5]). (Table 3) Additionally, which of the categories of DB that changed after the intervention period was investigated. It was discovered that 78% of subjects with biomechanical dysfunction from the experimental group normalized while none from the control group changed ($p < .001$, NNT = 2 [2-3]). (Table 4) For subjects with biochemical dysfunction, 27% from the experimental

Table 2. *Baseline characteristics, presented as mean (SD). ANOVA or Chi-Square (for Sex and Hi-Lo Test) for examination of baseline variables between groups.*

	Experimental N = 16	Control N = 19	p-value
Age	20.7 (2.2)	21.3 (1.3)	.32
BMI	23.6 (3.5)	23.2 (2.9)	.98
Activity Level Questionnaire[1]	5.0 (1.7)	4.6 (1.4)	.49
Female	14	15	.50
Breath Hold Time[2]	19.8 (6.2)	18.8 (3.9)	.59
ETCO2[3]	34.6 (2.3)	35.6 (3.9)	.38
SEBQ[4]	10.5 (6.5)	8.7 (7.8)	.47
Nijmegen[5]	11.6 (9.6)	8.5 (5.0)	.23
Hi-Lo Positive[6]	14	17	.85

BMI- Body mass index; ETCO2= End-tidal CO2 in mmHg (standard deviation); SEBQ= Self-Evaluation of Breathing Questionnaire

[1]Activity Level Questionnaire is on a 10-point scale with higher values indicating higher activity level.

[2]Breath Hold Time= Breath holding time at Functional Residual Volume measured in seconds.

[3]End-Tidal CO2 measured in mmHg, above 35 is considered normal.

[4]Self-Evaluation of Breathing Questionnaire, higher scores indicate greater breathing dysfunction.

[5]Nijmegen Questionnaire for Dysfunctional Breathing, higher scores indicate greater breathing dysfunction.

[6]Hi-Lo Test, when positive, indicates the presence of dysfunctional upper chest breathing

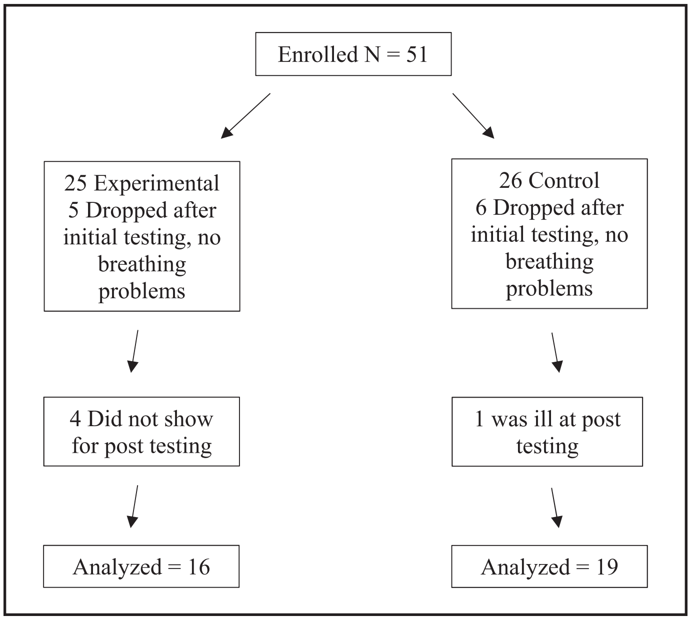

Figure 1. *Study enrollment flowchart.*

Table 3. *Frequency count of subjects (Chi-squared analysis) who demonstrated at least a one category improvement in dysfunctional breathing after the four-week intervention period between experimental and control groups.*

	Improved $\geq$ 1 Categories of Dysfunctional Breathing	No Improvement
Experimental	13	3
Control	4	15
p = .001		

Table 4. *Frequency count (Chi-squared analysis) of subjects who were free of the biomechanical category of dysfunctional breathing after the 4-week intervention period between experimental and control groups.*

	Resolved Biomechanical Dysfunction	No Improvement
Experimental	11	3
Control	0	17
p = .001		

group normalized compared to 25% from the control group (p = .91, NNT = 44 [2.4-INF]). (Table 5) There were only two subjects in each group that were above the threshold on the questionnaires used for the psychophysiological category. Of these four subjects, both in the experimental group and one in

Table 5. *Frequency count of subjects (Chi-squared analysis) who were free of the biochemical breathing dysfunction after the 4-week intervention period between experimental and control groups.*

	Resolved Biochemical Dysfunction	No Improvement
Experimental	3	8
Control	2	6
p = .91		

Table 6. *Within and between group differences on the mean Functional Movement Screen™ composite score before and after the four-week intervention period.*

	Pre-Test	Post-Test	p-value
Experimental	13.2 (1.9)	13.9 (1.7)	0.70
Control	12.9 (1.8)	13.4 (2.0)	0.50
Between group difference	0.30	0.50	

the control group scored below the threshold at post testing. This sample was too small to conclude anything related to the exercise intervention effects on this category.

There were no significant differences in FMS™ composite scores between or within groups after the intervention period (Table 6). To determine if any individuals improved on the FMS, the frequency count of subjects that improved from failing the FMS™ (any score of 0 or 1) to passing the FMS™ was also considered. Only one subject in the experimental group passed at pretest and there were no subjects in the control group that passed. At posttest the one experimental subject remained a pass while one subject in the control group improved to a pass.

DISCUSSION

The results of the current study demonstrate that the standardized exercise program utilized can be successful in improving one category of DB in otherwise healthy subjects. Most breathing intervention studies conducted in the past have grouped subjects with all categories of DB rather than grouping subjects by type or category of breathing dysfunction. Hagman et al[32] studied a breathing retraining program comparing subjects with DB to those with asthma and in their study a variety of tests and measures were utilized to diagnosis subjects with DB, including an assessment for upper chest breathing. The intervention was performed by trained physios and focused on volitional control of diaphragmatic breathing, education and breathing awareness. At the five year follow up, subjects improved on most measures including a reduction in Nijmegen score. The study methods did not provide for assessment of the presence of upper chest breathing at follow-up, making comparison to the current study challenging.

A study by Jones et al [33] tested a breathing retraining program in subjects with DB (based on a Nijmegen score of >23 and no asthma) and reported a significant change in Nijmegen score and a variety of other outcome measures. The Jones et al study did include breath hold time, reporting a mean at baseline of 25.2 seconds. However, it was not clear how the BHT was conducted, but the value is much higher than the baseline value of 19.2 seconds in the current study. Upper chest breathing was not assessed in the Jones et al study, and the mean age of the retraining group was 41 years, compared to 23 years in the current study, again, making direct comparison difficult. Since most studies have primarily utilized the Nijmegen to define DB, subjects in these studies have an average score at baseline above the cut off of 23. In the current study, the average score on the Nijmegen was nine with only two subjects exceeding the cut off of 23. It appears that subjects in the current study had overall less symptoms related to DB when compared to the majority of other studies and this is likely because they were disease free. Additionally, the intervention in each study mentioned was directed at hands on breathing retraining and the current study utilized a basic home exercise approach and did not include hands on re-training or awareness and education related to DB.

The biochemical measure (ETCO2) was not utilized in previous studies. Some suggest using BHT as a proxy for this measure. The current study demonstrated that subjects with hypocapnia did not improve with this home exercise approach with only three of eight subjects that were below the ETCO2 threshold of 35 mmHg at pretest improving to above the threshold at the four-week follow up in the exercise group and only three out of 11 changed in the control group. There were no significant differences between the groups related to mean resting ETCO2 values or number of subjects that changed at pretesting. Only one subject that crossed the 35 mmHg threshold changed greater than the standard deviation for the entire sample which was 3.1 mmHg. Perhaps the small number of subjects that did cross from below to above the threshold of 35 mmHg was due to the nature of the measure. Many individuals measured were very close to the 35 mmHg cut-off, thus, it is plausible that this is just a small physiological fluctuation that happened to fall at the established cut-off. Because the exercises used in the current study didn't show a change in the frequency of subjects with low ETCO2, or an improvement in mean values, further research is required to determine what type of intervention, if any, can demonstrate improvement of this metric. It is the experience of the lead author and in discussion with others that utilize a similar approach, subjects with low ETCO2 are challenging and take a hands-on approach and a much longer intervention period to see a change. Perhaps those with slightly low ETCO2 values, and no other signs or measures of DB, actually have acceptable functional breathing and being slightly below the commonly utilized cut-off of 35mmHg may not cause breathing symptoms for some individuals. Therefore, additional research is needed to determine the best intervention for subjects with hypocapnia or the cut-off may not be ideal for individuals with no other signs or symptoms of DB.

The authors hypothesized that improvements in breathing may result in changes in fundamental movement patterns. The results of the current study failed to demonstrate a significant improvement in FMS™ scores following the breathing retraining, suggesting other exercise intervention should be performed to improve movement such as demonstrated in previous studies.[34,35]

In the intervention group there were four subjects who did not return for follow-up testing. These subjects were not included in the main analysis because the primary outcome was a frequency count of subjects who were successful, rather than a continuous variable. When applying an intention to treat approach, assuming that the four dropouts did not change, the primary outcome is a control event rate drops to 65% with a NNT of 3 (2-11). The authors didn't include subjects in this study that were positive on the breathing screen, but then ultimately did not end up having a breathing problem, based on the diagnostic process utilized in this study. These subjects would have been considered as false positives on the breathing screen. Of the 11 subjects who were false positives on the screen, eight of them failed the screen be able to achieve BHT of < 25 seconds. With no other findings on the breathing tests utilized, these subjects could be considered not to have a breathing problem, or we could consider simply low BHT, in and of itself, as a breathing problem. Future research should investigate this and if BHT can change with targeted intervention.

While a randomized control trial is ideal, this matched controlled design allowed for a direct comparison between a true control group and the intervention group. The experimental group consisted of significantly more females and therefore the matched control group did as well. While this limits the findings to primarily female subjects, it is known that the prevalence of DB is greater in females.[18] Because of the design, blinding was limited as the researchers were aware which subjects were in the intervention group at post-test; however, the researchers were unaware of the category of DB of the subject, preserving some level of blinding.

CONCLUSION

A standardized set of home exercises was effective in reversing the biomechanical category of DB in 78% of young, otherwise healthy adults. These exercises did not affect the biochemical category of DB, and further research is needed to determine effective interventions for those with this category of DB. The sample in this study was too small to draw conclusions regarding the psychophysiological category of DB. Performing a simple set of home exercises may be an effective option for fitness and rehabilitation providers to suggest for otherwise healthy clients to normalize biomechanical breathing dysfunction.

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APPENDIX

Weeks 1-2

Breathing – Side Lying

Start by lying on your side with a small, soft rolled up towel placed between your hip and the floor. The towel will give you a target to breathe into during the exercise. Keep your neck and body relaxed and in a comfortable position. You may use a pillow under your neck for support and comfort.

Place a hand on your stomach. Breath in through your nose and into the hand placed on your stomach. You will feel your hand move out and your side pushing into the towel.

1) Breath in and out through your nose
2) Breathing in should last 3 seconds and be slow and controlled
3) Take a short pause, 1-2 seconds.
4) Breathing out should last 4-6 seconds and be slow and controlled
5) Take a longer pause, 2-3 seconds
6) Repeat steps 1-5
7) Once completed on one side switch to other side and repeat steps 1-6

Breathing – Hook Lying

Start by lying on your back with your knees bent up and feet flat on the floor. Neck and spine should be relaxed and in a straight line. You can use pillow to support your neck if needed. Place one hand over your heart and other hand over your belly button

1) Breath in and out through your nose
2) Breathing in should last 3 seconds and be slow and controlled
3) Take a short pause, 1-2 seconds
4) Breathing out should last 4-6 seconds and be slow and controlled
5) Take a longer pause, 2-3 seconds
6) Repeat steps 1-5

Breathing - T-Spine Rotation with Rib Grabs

Start by lying on your side. Bend your top knee until it is perpendicular with your body. Place a pillow under your knee and head to provide support. Reach across your body with the arm on top and grab your ribs.

1) Breath in through your nose
2) While breathing out roll your top shoulder behind you towards the floor. Do not move your knee off the pillow.
3) Hold this position and continue breathing in and out your nose continuing to roll back as close to the floor as possible with each breathe out
4) When you can no longer lean back any further stay in the position and take 3 breaths in and out
5) Return to the starting position
6) Switch to opposite side and repeat.

Four point with Flexion/Extension

Begin on all fours with the hands placed under your shoulders and knees placed under your hips. Bring your left foot up next to your left hand.

1) Take a normal breath in and out through your nose
2) While breathing in over 3 seconds, tilt your hips towards the floor, allow your belly to drop down and spine to move into extension from neck to low back.
3) Take a short pause, 1-2 seconds
4) While breathing out 4-6 seconds, tilt your hips towards the ceiling, arch your back like a cat to move your spine into flexion from neck to low back.
5) Take a short pause, 1-2 seconds
6) Patient preference
   a. Go directly into repeating steps 2-5
   b. Repeat steps 1-5
7) Once completed on left side switch to right side and repeat steps 1-6

Weeks 3-4

Four point with Flexion/Extension

*Same as above in Weeks 1-2

Half Kneeling Turns

Begin by positioning yourself in the tall-kneeling position as shown. Make sure to stay tall during exercise.

1) Take a normal breath in and out through your nose using the high/low breathing learned in weeks 1-2
2) While keeping the correct position turn your head slowly to the right while breathing in for 3 seconds
3) Take a short pause, 1-2 seconds
4) Turn your head back to the start position while breathing out for 4-6 seconds
5) Take a short pause, 1-2 seconds
6) Repeat steps 2-5
7) Switch to opposite side by breathing in while turning head to the left.

Toe Touch Progression

Start by standing tall with feet together and toes up on a 1-2 inch board. Bend your knees and place a rolled towel between them then stand tall again. Your feet should not move, if they do use a smaller rolled towel. This will feel very awkward, but do not change it. Normal high/low breathing should be used throughout exercise. You will breathe in when reaching up and breathing out when reaching down. If breathing changes during a movement, continue practicing movement until it can be completed without large change in breathing.

Phase 1:

1) With your hands facing forward reach up for the ceiling as high as possible.
2) Reach down until your fingertips touch your toes
   a. If your fingertips do not touch your toes:

i. Squeeze towel roll to help relax muscles so toes can be reached
ii. If above step does not work begin to bend knees slightly until toes can be reached
3) Repeat steps 1-2
   a. If small knee bend was used, try to bend knees less during each repetition but still make it close to your toes.
   b. There may be tightness in your calves, backs of knee, hamstrings, and low back

Phase 2:

The only difference with phase 2 is the positions of the 1-2 inch board. Place the board under your heels. Place towel roll in same position as phase 1. Repeat steps 1-3 from phase 1.